

## Environmental Protection Agency

## § 89.413

(2) Zero and span the HFID at the analyzer ports.

(3) Analyze the background air sample bag through the analyzer ports.

(4) Analyze the background air through the entire sample probe system.

(5) If the difference between the readings obtained greater than or equal to 2 percent of full scale deflection, clean the sample probe and the sample line.

(6) Reassemble the sample system, heat to specified temperature, and repeat the procedure in paragraphs (e)(1) through (e)(6) of this section.

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56996, 57016, Oct. 23, 1998]

### § 89.412 Raw gaseous exhaust sampling and analytical system description.

(a) *Schematic drawing.* An example of a sampling and analytical system which may be used for testing under this subpart is shown in Figure 1 in appendix B to subpart D. All components or parts of components that are wetted by the sample or corrosive calibration gases shall be either chemically cleaned stainless steel or inert material, for example, polytetrafluoroethylene resin. The use of "gauge savers" or "protectors" with nonreactive diaphragms to reduce dead volumes is permitted.

(b) *Sample probe.* (1) The sample probe shall be a straight, closed-end, stainless steel, multi-hole probe. The inside diameter shall not be greater than the inside diameter of the sample line plus 0.03 cm. The wall thickness of the probe shall not be greater than 0.10 cm. The fitting that attaches the probe to the exhaust pipe shall be as small as practical in order to minimize heat loss from the probe.

(2) The probe shall have a minimum of three holes. The spacing of the radial planes for each hole in the probe must be such that they cover approximately equal cross-sectional areas of the exhaust duct. See Figure 1 in appendix A to this subpart. The angular spacing of the holes must be approximately equal. The angular spacing of any two holes in one plane may not be  $180^\circ \pm 20^\circ$  (that is, section view C-C of Figure 1 in appendix A to this subpart). The holes should be sized such that

each has approximately the same flow. If only three holes are used, they may not all be in the same radial plane.

(3) The probe shall extend radially across the exhaust duct. The probe must pass through the approximate center and must extend across at least 80 percent of the diameter of the duct.

(c) *Sample transfer line.* (1) The maximum inside diameter of the sample line shall not exceed 1.32 cm.

(2) If valve V2 is used, the sample probe must connect directly to valve V2. The location of optional valve V2 may not be greater than 1.22 m from the exhaust duct.

(3) The location of optional valve V16 may not be greater than 61 cm from the sample pump.

(d) *Venting.* All vents, including analyzer vents, bypass flow, and pressure relief vents of regulators, should be vented in such a manner to avoid endangering personnel in the immediate area.

(e) Any variation from the specifications in this subpart including performance specifications and emission detection methods may be used only with prior approval by the Administrator.

(f) Additional components, such as instruments, valves, solenoids, pumps, switches, and so forth, may be employed to provide additional information and coordinate the functions of the component systems.

(g) The following requirements must be incorporated in each system used for raw testing under this subpart.

(1) [Reserved]

(2) The sample transport system from the engine exhaust pipe to the HC analyzer and the NO<sub>x</sub> analyzer must be heated as indicated in Figure 1 in appendix B of subpart D.

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56996, 57016, Oct. 23, 1998]

### § 89.413 Raw sampling procedures.

Follow these procedures when sampling for gaseous emissions.

(a) The gaseous emission sampling probe must be installed at least 0.5 m or 3 times the diameter of the exhaust pipe—whichever is the larger—upstream of the exit of the exhaust gas system.

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(b) In the case of a multi-cylinder engine with a branched exhaust manifold, the inlet of the probe shall be located sufficiently far downstream so as to ensure that the sample is representative of the average exhaust emissions from all cylinders.

(c) In multi-cylinder engines having distinct groups of manifolds, such as in a "Vee" engine configuration, it is permissible to:

(1) Sample after all exhaust pipes have been connected together into a single exhaust pipe.

(2) For each mode, sample from each exhaust pipe and average the gaseous concentrations to determine a value for each mode.

(3) Sample from all exhaust pipes simultaneously with the sample lines connected to a common manifold prior to the analyzer. It must be demonstrated that the flow rate through each individual sample line is  $\pm 4$  percent of the average flow rate through all the sample lines.

(4) Use another method, if it has been approved in advance by the Administrator.

(d) All gaseous heated sampling lines shall be fitted with a heated filter to extract solid particles from the flow of gas required for analysis. The sample line for CO and CO<sub>2</sub> analysis may be heated or unheated.

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56996, 57016, Oct. 23, 1998]

#### § 89.414 Air flow measurement specifications.

(a) The air flow measurement method used must have a range large enough to accurately measure the air flow over the engine operating range during the test. Overall measurement accuracy must be  $\pm 2$  percent of the maximum engine value for all modes. The Administrator must be advised of the method used prior to testing.

(b) When an engine system incorporates devices that affect the air flow measurement (such as air bleeds) that result in understated exhaust emission results, corrections to the exhaust emission results shall be made to account for such effects.

[59 FR 31335, June 17, 1994. Redesignated and amended at 63 FR 56996, 57017, Oct. 23, 1998]

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#### § 89.415 Fuel flow measurement specifications.

The fuel flow rate measurement instrument must have a minimum accuracy of 2 percent of the engine maximum fuel flow rate. The controlling parameters are the elapsed time measurement of the event and the weight or volume measurement.

[63 FR 57017, Oct. 23, 1998]

#### § 89.416 Raw exhaust gas flow.

The exhaust gas flow shall be determined by one of the methods described in this section and conform to the tolerances of Table 3 in appendix A to subpart D:

(a) Measurement of the air flow and the fuel flow by suitable metering systems (for details see SAE J244. This procedure has been incorporated by reference. See § 89.6.) and calculation of the exhaust gas flow as follows:

$$G_{EXHW} = G_{AIRW} + G_{FUEL} \quad (\text{for wet exhaust mass})$$

or

$$V_{EXHD} = V_{AIRD} + (-.767) \times G_{FUEL} \quad (\text{for dry exhaust volume})$$

or

$$V_{EXHW} = V_{AIRW} + .749 \times G_{FUEL} \quad (\text{for wet exhaust volume})$$

(b) Exhaust mass calculation from fuel consumption (see § 89.415) and exhaust gas concentrations using the method found in § 89.418.

[59 FR 31335, June 17, 1994. Redesignated at 63 FR 56996, Oct. 23, 1998]

#### § 89.417 Data evaluation for gaseous emissions.

For the evaluation of the gaseous emission recording, the last 60 seconds of each mode are recorded, and the average values for HC, CO, CO<sub>2</sub>, and NO<sub>x</sub> during each mode are determined from the average concentration readings determined from the corresponding calibration data.

[59 FR 31335, June 17, 1994. Redesignated at 63 FR 56996, Oct. 23, 1998]